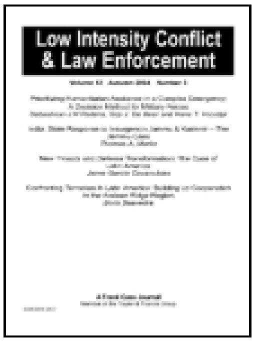

Routledge
Taylor & Francis Group

Low Intensity Conflict & Law Enforcement

ISSN: 0966-2847 (Print) 1744-0556 (Online) Journal homepage: http://www.tandfonline.com/loi/flic20

Terrorists and Unconventional Weapons: Is the Threat Real?

Debra Bennett

To cite this article: Debra Bennett (2004) Terrorists and Unconventional Weapons: Is the Threat Real?, Low Intensity Conflict & Law Enforcement, 12:1, 20-50, DOI: 10.1080/0966284042000306721

To link to this article: http://dx.doi.org/10.1080/0966284042000306721

Published online: 24 Jan 2007.

Submit your article to this journal

Article views: 231

View related articles

Full Terms & Conditions of access and use can be found at
http://www.tandfonline.com/action/journalInformation?journalCode=flic20

Download by: [University of Sussex Library] **Date:** 01 June 2016, At: 21:37

Terrorists and Unconventional Weapons: Is the Threat Real?

DEBRA BENNETT

For years the government has been concerned about terrorists and unconventional weapons – but is the threat real? The threat is definitely real, but may not be from the source you would expect. The threat is not from biological and chemical weapons as experts seems to think – yes the information is readily available, but production and dissemination are far more complicated than what the public has been lead to believe. Even the threat from radiological devices, otherwise known as 'dirty bombs', is not realistic. The weapon is extremely dangerous to make, very heavy and produces a low mass casualty rate. Instead the threat stems from terrorists acquiring, producing or stealing nuclear weapons. Nuclear weapons today are small enough that we would never be able to find them, and they can be remotely detonated.

Is the threat of terrorists and unconventional weapons (i.e., weapons of mass destruction (WMD)) real? Since the events of 11 September 2001, Americans have been bombarded with scary scenarios: a crop duster killing thousands by spraying a town in nerve gas; or a terrorist infected with smallpox takes a commercial flight to America, and infects everyone he comes into contact with, creating an epidemic.[1]

Are these scenarios possible? Most terrorism analysts say yes, but are highly unlikely – at least for right now. The examples mentioned above are extremely difficult to manage, and because of this terrorists risk exposure; exposing themselves to a WMD reaction or identifying themselves in public. The examples mentioned also require enormous preparation and investment in personnel, money and strategy.

William J. Perry, former Secretary of Defense, in the winter of 2001, wrote 'nuclear or biological weapons in the hands of terrorists or rogue states ... constitute the greatest single danger to American security – and a threat that is becoming increasingly less remote'.[2] While not in total disagreement with William Perry, this article instead will take the approach that the most

Low Intensity Conflict & Law Enforcement, Vol.12, No.1 (Spring 2004), pp.20–50
ISSN 0966-2847 print/ISSN 1744-0556 online
DOI: 10.1080/0966284042000306721 © 2004 Taylor & Francis Ltd

probable form of WMD attack is nuclear and not biological *or* chemical *or* radiological.

Chemical, biological, radiological, and nuclear (CBRN) weapons are becoming more accessible to a wider range of groups. First, the knowledge and materials are out there for terrorists to get. Second, the dominance of the US military around the world, and the threat they pose may lead terrorists to believe their only solution is to use WMD. Finally, the nature of non-state violence is changing in ways that suggest rising CBRN risks.[3] In 2002, there were 23 instances worldwide of sub-national actors using, possessing, attempting to acquire, plot and/or threaten WMD.[4] While the number is not large, it does raise some concerns. As Table 1 demonstrates, terrorists have managed to acquire, threaten, possess, use and more often than not talk less about the use of WMD.

The question is which technique are they more likely to use: biological, chemical, radiological or nuclear? Ask any expert and you can get a different answer. Many believe that terrorists would attack biologically: advances in biotechnology have obviated many of the old problems in handling and preserving biological agents, and many are now generously available for scientific research. Biological weapons combine maximum destructiveness and easy availability.[5] In contrast, this article will demonstrate that biological weapons are not a threat as originally thought. Contrary to popular belief, turning a virus or microbe into a potent weapon is not easy and involves more than just getting your hands on a Petri dish of anthrax bacteria. Developing

TABLE 1
TERRORIST GROUPS WITHIN EACH REGION: USES, POSSESSIONS, ATTEMPTED ACQUISITIONS, PLOTS, THREATS WITH POSSESSION AND HOAXES

Region	2000	2001	2002	Hoax 2000	Hoax 2001	Hoax 2002
United States/Canada	7	7	4	22	566	41
Asia	16	5	1	0	7	1
Europe	3	5	3	0	11	17
Middle East & North Africa	11	1	5	0	4	0
Latin America	0	2	3	0	5	2
Russia & NIS	7	3	4	3	3	1
Sub-Saharan Africa	2	0	2	0	1	5
Australia & Oceania	1	2	1	0	6	4
Worldwide	1	0	0	0	0	0
Total	48	25	23	25	603	71

Source: Wayne Turnbull and Praveen Abhayaratne, '2002 WMD Terrorism Chronology: Incidents Involving Sub-National Actors and Chemical, Biological, Radiological and Nuclear Materials', Monterey Institute of International Studies, p.3, available at ⟨http://cns.miis.edu/pubs/reports/pdfs/cbrn2k2.pdf⟩, accessed 23 November 2003.

bacteria into a weapon involves several steps, and even if a terrorist group accomplishes it, they still have to cope with environmental conditions.[6]

While chemical weapons are extremely dangerous, they are also not easy to acquire or use, thereby making them a poor choice for terrorists. Synthesizing chemical warfare agents is difficult, especially in home laboratories, and the supertoxic chemicals are extremely dangerous to handle and deliver in the mass quantities needed to inflict sizable casualties.[7]

Radiological terrorism, while quite dangerous and controversial among experts, is another option for terrorists. According to the Federal Emergency Management Agency (FEMA), radiological weapons appeal to terrorists because:

> They require very little technical knowledge to build and deploy compared to that of a nuclear device. Also, these radioactive materials used widely in medicine, agriculture, industry and research are much more readily available and easy to obtain compared to weapons grade uranium or plutonium.[8]

Although the materials are easy to acquire, and there is a wide range of attack modes that could be utilized, the radiological attack would probably only sicken people and contaminate the area, not kill thousands of people outright, which is the terrorists ultimate goal.[9]

Nuclear terrorism is a realistic threat. Terrorist groups, depending on their financial capabilities, ‘support staff’, time frame, and desires, have many options available to them. They can attempt to acquire fissile material necessary for nuclear weapons and try to produce their own. They can steal the nuclear material, or steal and/or acquire a ready-made nuclear weapon. Or, the best scenario for a terrorist would be to attack a nuclear power plant.

In conclusion, while there is a low probability that terrorists will use weapons of mass destruction in the near future, we cannot rule out the concept since groups such as Aum Shinrikyo who tried to develop their own programme, and Al Qaeda which has publicly made known their desire to obtain them. Western nations must be on guard against the threat posed by nuclear terrorism.

SIGNIFICANCE OF THE ISSUE

Aum Shinrikyo’s sarin gas attack in the Tokyo subway system in 1995 increased concerns that terrorists might use unconventional weapons on US soil. There are several questions that have been left unanswered; these questions can be grouped together as the three ‘w’s’ of WMD terrorism. W*hy* terrorists would want to follow Aum Shinrikyo’s example? *Who* would be the most likely to follow their lead? W*hy* has Aum Shinrikyo’s attack yet to be duplicated?[10]

Unlike the provincial attacks with guns and bombs, a germ, gas, or nuclear attack is guaranteed headlines, and has a psychological impact. There are many reasons for terrorists to use WMD:

1. Kill as many people as possible – could give a terrorist group the potential ability to wipe out thousands, possibly hundreds of thousands, in a single strike.
2. Exploit the classic weapon of the terrorist – fear.
3. The desire to negotiate from a position of unsurpassed strength.
4. A biological attack could provide certain logistical and psychological advantages unlike a conventional bombing.
5. Cause economic and social damage by targeting a state or region's agricultural sector.[11]

As a general rule, terrorists tend to be conservative and stick to proven tactics. Occasionally, they develop new techniques and new technologies, sometimes going so far as to create new norms. In the 1960s, terrorists crossed the moral threshold: they began to launch random attacks, killing people indiscriminately. The 1970s saw hostage-taking become the popular trend. Hijacking planes and attacking embassies emerged as the tactic in the late 1970s and early 1980s. In 1984, the Rajneeshee cult poisoned salad bars in Oregon, making 750 people ill; their goal was to influence the local elections. In 1985 Sunni terrorists began blowing up airplanes, for example, killing 363 people on an Air India jet, and later claimed responsibility for the World Trade Center bombing in 1993.[12] The Aum Shinrikyo (Aum) religious cult started their own trend in the 1990s – using and/or attempting to use or acquire nuclear, chemical and biological weapons to kill mass quantities of people. Aum was able to produce chemical weapons, and used them in a Tokyo subway in 1995, albeit not that successfully.[13]

Today unconventional weapons and their components are easier for terrorists to acquire. The black market is now offering nuclear materials, guidance systems and other components of nuclear weapons. Law enforcement officials have already seized hundreds of caches of stolen nuclear materials, many of which are nonfissile – radioactive sources that could be used in radiation dispersal devices. For example, South African biological weapons experts were caught offering their expertise to Libya, and many fear that Russian weapons scientists might provide weapons expertise and material to Iran. However, nuclear bombs are still harder to acquire and use than a fertilizer bomb, or a driving a suicide mission into a building (i.e., conventional weapons). Yet if a terrorist is determined to obtain weapons of mass destruction, he is most likely to acquire a nuclear weapon or find a way to attack a nuclear power plant.

THREAT OF WMD

Biological Terrorism

> Biological weapons have received less attention than [other weapons of mass destruction] but probably represent the greatest danger.
>
> – Richard Betts, 1998[14]

This analysis is not valid. Biological terrorist threats have been multiplying despite the fact that few incidents of such acts of terrorism have actually occurred. A terrorist is more likely to threaten to use a biological agent rather than actually use it. In 2001, there were over 600 anthrax hoaxes either mailed or delivered to various government, entertainment and/or judicial offices.[15] Producing a biological weapon involves three essential technical steps. (1) acquire seed stock of a pathogenic or toxin-producing organism, (2) produce the microorganism or toxin in bulk, (3) develop a system capable of dispersing the chosen agent as a respirable aerosol without deactivating it in the process.[16]

Biological agents are divided into three categories: Category A, B and C, according to subsequent disease types (See Table 2). The 'Category A' list includes germs that cause anthrax, botulism, plague, smallpox, tularemia, and hemorrhagic fever viruses like Ebola. These have the greatest potential for adverse public health impact with mass casualties and require the most broad-based public health preparedness efforts. 'Category A' agents also have a moderate to high potential for large-scale dissemination or a heightened general public awareness that could cause mass public fear and civil disruption.[17]

The 'Category B' list includes Q fever, Brucellosis, Encephalitis, Typhus fever, and Toxis Syndromes. Most 'Category B' agents also have some potential for large-scale dissemination with resultant illness, but generally cause less illness and death and therefore would be expected to have lower medical and public health impact. These agents also have lower general public awareness than 'Category A' agents and require fewer special public health preparedness efforts.[18]

The 'Category C' list includes emerging threat agents such as Nipah virus, Venezuelan equine (VEE), eastern equine (EEE) and western equine encephalomyelitis (WEE) viruses. Biological agents placed in 'Category C' are currently not believed to present a high bioterrorism risk to public health but could emerge as future threats.[19]

There are approximately four main ways for terrorists to acquire biological warfare capabilities. The first is to purchase a biological agent from one of the world's 1,500 germ banks. The second is to steal it from a research laboratory, hospital or public health service laboratory, where agents are cultivated for diagnostic purposes. The third is to isolate and culture the desired agent from

TABLE 2

ESTIMATES OF CASUALTIES FROM A HYPOTHETICAL BIOATTACK BASED ON THE RELEASE OF 50 KG OF VARIOUS AGENTS BY AN AIRCRAFT FLYING ALONG A 2 KM PATH UPWIND OF A CITY OF HALF A MILLION PEOPLE

Agent	Casualties	Fatalities	Type	Symptoms
Rift Valley Fever (spread among animals, and human by the bite of infected mosquitoes)	35,000	400	Viral	Fever, generic pain, back pain, dizziness, weight loss
Typhus (infective rat fleas contaminate fresh skin wounds or the flea bite site)	85,000	19,000	Bacterial	Fever, chills, headache, exhaustion alternating with agitation, all followed by a rash
Brucellosis (found in unpasteurized milk)	125,000	500	Bacterial	Fever, headache, weakness, profuse sweating, chills, weight loss and generalized aching
Q Fever (zoonotic disease, contracted from animals)	125,000	150	Bacterial	• Acute: Fever, headache, muscle pains • Chronic: Prolonged fever, night sweats, chills, fatigue, shortness of breath
Anthrax (exposure to infected animals or to tissue from infected animals or when anthrax spores)	125,000	95,000	Bacterial	Nausea, loss of appetite, vomiting, fever are followed by abdominal pain, vomiting of blood, and severe diarrhea

Sources: Ronald M. Atlas, ‘Combating the Threat of Biowarfare and Bioterrorism: Defending Against Biological Weapons is Critical to Global Security’, *BioScience*, June 1999, available at ⟨http://www.findarticles.com/cr_dls/m1042/6_49/54823664/print.jhtml⟩; WHO, ‘Rift Valley Fever’, Fact Sheet No.207, September 2000, available at ⟨http://www.who.int/inf-fs/en/fact207.html⟩; Center for Disease Control, ‘Tick-Borne Encephalitis’, available at ⟨http://www.cdc.gov/ncidod/dvrd/spb/mnpages/dispages/TBE.htm⟩; Virginia Department of Health, ‘Typhus Fever (Flea-borne)’, June 1998, available at ⟨http://www.vdh.state.va.us/epi/typhusf.htm⟩; Center for Disease Control, ‘Brucellosis’, December 2002, available at ⟨http://www.cdc.gov/ncidod/cbmd/diseaseinfo/brucellosis_t.htm⟩; Henry Ford Health System, ‘Disease – Q Fever’, 31 July 2002, available at ⟨http://www.henryfordhealth.org/15128.cfm⟩; Center for Disease Control, ‘Tularemia: Key Facts About Tularemia’, 10 October 2003, available at ⟨http://www.cdc.gov/ncidod/dvbib/tularemia.htm⟩; Center for Disease Control, ‘Questions and Answers About Anthrax’, 2 June 2003, available at ⟨http://www.bt.cdc.gov/agent/anthrax/faq/index.asp⟩. All websites accessed 9 November 2003.

natural sources, and the final way is to obtain the biological agent from a rogue state, a disgruntled government scientist or a state sponsor.[20]

A former senior official in the US military's biological warfare programme was quoted in the *New York Times* as saying 'acquiring the "most infectious and virulent culture for the seed stock is the greatest hurdle"'.[21] Acquiring a biological agent of sufficient virulence is only one of the prerequisites in preparing a bioterrorism attack. Ken Alibek, one of the former Soviet Union's leading biological weapons scientists, has argued, the

> most virulent culture in a test tube is useless as an offensive weapon until it has been put through a process that gives it stability and predictability. The manufacturing technique is, in a sense, the real weapon, and it is harder to develop than individual agents.[22]

Airborne viral agents are extremely difficult to work with, since the mass production, packaging and storage of viruses are by themselves difficult and complicated tasks, demanding advanced biotechnical skills, and risky to the people involved.

The probability of a major high-tech biological attack by either a state or a sophisticated terrorist group seems extremely unlikely. However, smaller, less lethal acts of bioterrorism, such as the anthrax attacks, seem more probable, and have happened. On 19 September 2001, a photo editor at the supermarket tabloid *The Sun* received and opened a letter addressed to Jennifer Lopez. The letter was laced with anthrax powder. On 5 October 2001 Mr Stevens died.[23]

Despite the instance mentioned above, terrorism with biological weapons is likely to remain rare. This is especially true for attacks intended to create mass casualties, which require a level of technical sophistication likely to be possessed by few terrorist groups.[24]

Availability of Information. Despite the fact that the general public believes that is it relatively easy to acquire and use high amounts of lethal quantities of biological agents, analysts are not as sure. There is no consensus about how much scientific and technological expertise and prior training is needed. Some say that having an 'experimental microbiologist and a pathologist, or someone who combines these capabilities, would be crucial ... supplemented with a little help and advice from an aerosol physicist and a meteorologist'.[25] Yet others believe that in order for terrorists to achieve a mass-casualty biological attack they would have to have a team of people highly trained in microbiology, pathology, aerosol physics, aerobiology and meteorology.[26]

Concern arises over terrorists acquiring biological weapons due to their apparent accessibility. First, pathogenic biological agents most suitable for weapons applications are identified in widely published sources, and technical information on how to produce them in bulk is available in scientific literature.

Second, the seed stocks for many biological warfare agents can be obtained from a variety of sources. Third, the equipment and supplies needed to produce biological warfare agents in bulk have legitimate commercial applications and can be bought with little difficulty. Fourth, preparing an agent for effective aerosol dissemination, and manufacturing an appropriate sprayer system, poses a significant technical hurdle to weapons acquisition, but it is one that can be overcome. Fifth, clandestine biological weapons acquisition has few externally observable indicators to arouse suspicions of law enforcement agencies. Sixth, even with an inefficient dissemination system, a single biological agent can produce thousands or tens of thousands of casualties in a densely populated target; a more efficient dissemination technique or attacks involving larger amounts of agent could cause hundreds of thousands of casualties.[27]

Despite how easy it might be for terrorists to acquire biological agents, selection of them is another matter. Selection of biological agents depends on a number of variables, (i.e., the kind of organism affected, the effects on the victims, the requirements of agent cultivation and the requirements of agent delivery) which determine the main aspects of a biological weapons effort. The terrorist could choose an agent to affect humans, animals or plants. A terrorist can also choose a biological agent to sicken, incapacitate, or kill; to spread from person to person or to affect only those initially exposed. Biological agents can also vary in how difficult they are to cultivate and to disseminate.[28]

Manufacturing and Production. Instructions for how to mass-produce, purify and concentrate microbes can be found in textbooks, scientific journals and the Internet. ‘Cookbooks’ for some biological agents, like botulinum toxin and ricin, are known to be popular within terrorist circles. The first production step is to inject the seed culture into a flask that contains a suitable growth medium. If the correct temperature, acidity and other conditions are maintained, the seed culture will multiply. The people in charge of the fermentation process have to guard against genetic mutations and contaminants that could weaken or kill the biological agent. However, the slightest mistake with growth, temperature or other variables can result in failure of the biological agent.[29]

Additional procedures to create a dry agent are technically advanced, extremely challenging and very hazardous. Producing a dry agent can increase the likelihood that infection would be induced in humans. Because of the complexity of the process, a lot of experts have concluded that terrorists are unlikely to have the technical finesse to produce dry agents. In addition, the more technically sophisticated procedures such as the one mentioned above, is not likely to be mentioned in a terrorist cookbook.

Delivery of Biological Weapons. Delivery of a biological agent can be accomplished with advanced technologies or much simpler, rudimentary devices. One way to deliver liquid and dried agents is to do it as an aerosol. Other ways include contamination of water and food, infected insects can carry the agent, or individuals can be injected with the biological agent.[30] Additional dispersal methods include hand-held or truck mounted sprayers, crop dusters or placing an aerosol generator on an offshore ship. These methods will carry the biological agents downwind, potentially infecting all those that live in a large area.[31] In order for these delivery techniques to be effective, terrorists need to have prepared the agent properly and worked through several technical calculations. For open-air delivery, the meteorological conditions and the effectiveness of the agents under those conditions must be taken into account.[32] In sum, terrorists cannot count on simply filling the delivery system with agent, pointing the device and flipping the switch to activate it.

The solution to terrorists' dispersal woes might appear to be a quick stop at a local hardware/supply store to purchase one of several industrial, agricultural, or even medical aerosol generators or sprayers. However, most of the off-the-shelf sprayers do not generate enough small particle aerosols, therefore, purchased equipment would have to be modified or a sprayer built from scratch. These modifications while not initially appearing to be complicated turn out to be quite significant and delicate because of the need to keep the microorganisms alive.[33]

Conclusion. Despite all the hype, producing a weapon based on bacterial agents is extremely difficult. There are several key steps involved in developing bacteria or a virus into a weapon: acquiring an active strain and growing it, preparing it into a form for dissemination, and developing an appropriate delivery device. Even if a terrorist is able to accomplish this, viruses and/or bacteria can be degraded by environmental conditions. Creating a formulation that can protect the biological agent requires a high level of technical skill and a sustained testing effort to ensure that the organism remains viable. Minor variations in the formulation of the agents can kill the organism or render them inactive. The US and Soviet governments spent decades and billions of dollars working on all of these steps for their biological weapons programs and still encountered difficulties along the way.[34] Few terrorist organizations have the resources and time to develop a biological weapons programme.

Chemical Terrorism

> It is paradoxical that chemical and biological terrorism has come to occupy such a high position on the worry list of top US government officials when so little is known about the actual threat.
>
> – Jonathan B. Tucker and Amy Sands, 1999[35]

Chemical weapons are the most implausible type of weapon to be used in a terrorist strike because of the complexity of the chemical agents. Although any of the chemical agents could be used in causing mass-casualty attacks, it is unlikely that terrorists would use them. In 2002, there were 20 instances in which terrorists acquired chemical agents with the intent to use them as a weapon of mass destruction; the problem was the chemicals they chose lacked the potential to inflict mass casualties. Chemical weapon casualties for 2002 stem from three incidents: seven people were killed and 47 injured in a poisoning incident involving a religious sect of the Johanne Marange Apostolic Church in Zimbabwe, four people were injured in ammonia gas cylinder attacks perpetrated by the Revolutionary Armed Forces of Columbia (FARC), and a forensic scientist was injured when an unknown chemical was sprayed in his face.[36] While the number of low-tech chemical attacks did decrease from 25 in 2001 to 20 in 2002,[37] terrorists were able to achieve results – death and injury, just not on a large-scale.

There are four basic categories of chemical weapons: blister agents that destroy exposed skin tissue (i.e., mustard gas); blood agents that, when inhaled, block oxygen circulation within the body (i.e., hydrogren cyanide and cyanogen chloride); choking agents that inflame bronchial tubes and lungs, potentially causing asphyxiation (i.e., phosgene and chlorine); and nerve agents that break down the nervous system, causing respiratory failure and death within minutes (i.e., tabun, sarin and VX).[38]

In the case of blister agents, while they are capable of causing injuries on a large scale, they would require extremely large amounts of choking agents to produce mass fatalities. Nerve agents, like VX, are unlikely because of the technical challenges associated with weaponising them.[39]

Technology needed to make such weapons is widely spread throughout the world since it is used in basic pharmaceutical and industrial production. Chemical agents can also differ in lethality, the means of entering the body, speed of action, how long they remain dangerous once airborne and whether the agent is a solid, liquid or a gas. Chemical weapons also differ in toxicity.[40]

These weapons are highly toxic liquid and gaseous substances that can be dispersed in bombs, rockets, missiles, artillery, grenades or spray tanks. If inhaled or absorbed through the skin, man-made agents can incapacitate for short periods of time or kill with just a few microscopic drops, depending on the agent. The effects of the chemical agents can begin immediately or develop after a short period of time.[41]

Physical characteristics of chemical agents range from colourless, odourless liquids to bitter, oily fluids. Many of the agents evaporate quickly when released into the atmosphere, while others, including those like VX and mustard gas, are relentless and raise long-term health and environmental concerns. Of the four poison gas categories, the nerve gases are the deadliest.

TABLE 3
COMMERCIAL APPLICATIONS OF CHEMICAL WEAPONS

Type of chemical agent	Commercial uses of the chemical ingredients
Mustard agents	* ballpoint pen ink, *manufacture of plastics, paper, and rubber, *photographic developing solutions, *textile dyes, *pesticides, *cosmetics, *detergents, *pharmaceuticals, *insecticide, *waxes and polishes, *toiletries,
Tabun	*gasoline additives, *insecticides, *flames retardants, *pharmaceuticals, *detergents, *pesticides, *missile fuels,
Sarin	*flame retardants, *gasoline additives, *paint solvents, *ceramics
Soman	* lubricant additives, *cleaning and disinfectant for a brewery, *dairy and other food processing equipment
VX	*organic synthesis, *insecticide, *lubricant oil additives, *pyrotechnics

Sources: Amy E. Smithson and Leslie-Anne Levy, ‘Axatia: The Chemical and Biological Terrorism Threat and US Response’, Report No.35 (October 2000), p.49, quoting the Central Intelligence Agency, *The Chemical and Biological Weapons Threat* (Washington, DC.: Central Intelligence Agency, 1996), pp.9–16; on mustard and tabun ingredients, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, OTA-BP-ISC-115 (Washington, DC: US Government Printing Office, December 1993), pp.23–4.

Availability of Information. Because chemicals are essential to many consumer products, the chemical industry is found in practically every corner of the globe (see Table 3). The United States has the world’s largest chemical industry. The chemicals and equipment used by the industry for commercial products can be used to produce warfare agents. Of particular concern to poison gas production are the chemicals and equipment used to make pesticides, fertilisers and pharmaceuticals. Sub-national actors can purchase these commodities on the open market, from commercial traders, equipment manufacturers and laboratory supply houses. The chemical agents could also be bought through mail order or over the Internet.[42]

In 1985, an organisation known as the Australia Group, consisting of 30 nations, formed to force uniform export controls on chemical precursors and manufacturing equipment to frustrate and slow down the progress of aspiring chemical weapons proliferators. If an Australia Group member country denies an export license out of concern for possible weapons use or diversion, the rest of the group is informed of the decision, and is provided a list of what items were requested. One drawback of the Australia Group is that licensing procedures do not apply to domestic sales; therefore, terrorist groups could purchase fairly small quantities of chemicals from a firm or local stores without stirring up suspicion.[43]

Like chemical ingredients, equipment needed to make chemical warfare agents is readily available commercially, but may not be logistically or economically viable. In order to set up a poison gas production line, terrorists need reactors and agitators, chemical storage tanks, containers and receivers, heat exchangers or condensers for temperature control, distillation or absorption columns to separate the chemical compounds, and valves, multi-walled piping and pumps to move chemicals between reactors and other containers. A first-class facility would have safety equipment like toxic gas monitors as well as incinerators and filling equipment, and the equipment would be corrosion resistant.[44] A full-scale mustard production facility, complete with air-handling capacity, would cost between $5 and $10 million. A lab needed for the full-up plant production of sarin, soman or tabun could cost approximately $20 million, thereby reducing the number of terrorist groups that could develop a chemical WMD programme.[45]

Manufacturing and Production. Some experts believe that anyone who excelled in high-school chemistry has enough knowledge to make poison gas, yet others say that graduate-level chemistry skills are a definite prerequisite for chemical weapons work.[46] Experts also disagree on what type of agent(s) terrorists might choose to use. Some say they would not use choking agents simply because they would have to produce too much for an attack, and blister agents harm but do not kill large numbers of people. Sarin, some believe, is the most likely warfare agent, because it is a highly toxic agent and is relatively easy to produce. Yet other experts believe that mustard gas is easier to produce than nerve agents.[47]

Technically, producing nerve agents can be a challenge, but it is not impossible. The reactor temperature must be monitored constantly, and since water reacts with some of the chemicals used, appropriate heat exchangers must be used. Specifically, for the production of tabun, hydrogen cyanide, which is a highly toxic reagent, has to be contained, or the repercussions could be deadly.[48] The production of sarin, soman and VX requires the use of highly corrosive chemicals like hydrogen fluoride and hot hydrochloric acid, and a technically demanding alkylation reaction not used regularly in industrial practice. In addition, the distillation process necessary to achieve a pure agent is extremely dangerous and hazardous, thereby decreasing the potential for terrorists to utilise chemical weaponry.[49]

If terrorists wanted to activate their chemical agent in a large crowd, they would have to produce a large amount. In 1999, the Pentagon estimated that for an open-air disbursement of sarin gas to kill humans would require 22 pounds to kill approximately 50 people, 220 pounds to kill 500 and 2,200 pounds to cause casualties in the tens of thousands.[50] However, if the quantities were released indoors, quantity requirements would not be as high because air current could not dissipate the gas as quickly.

Delivery of Chemical Weapons. Delivery options for chemical weapons range from low tech to high tech. Toxic chemicals can be employed to taint food or water supplies, added to weapons, or distributed by an aerosol/spray method. If a terrorist were to drop chemical agents from the sky and have them fall to the ground, the coating of the surface of the agent would evaporate and produce a vapour. The droplets from the sky constitute skin exposure hazards making this ideal for inhalation – the quickest and deadliest for exposure.[51]

Choosing a spray technique could provide terrorists with the most controlled and reliable means of dissemination. Sprayers can be mounted on aircraft, trucks, boats, crop dusters or ground-based sprayers could be placed in close proximity to a building's ventilation system. The difficulty in dispersing chemical agents outside is that 'at a minimum, it may be assumed that 90 percent of the dispersed agent will not reach the intended target doses sufficient to cause casualties'.[52] In sum, successful delivery of chemical weapons, which encompasses getting the right balance of the chemical agent and retaining long enough for inhalation to occur, is difficult because chemical agents are extremely susceptible to weather conditions.[53]

Chemical agents are affected by temperature, sunlight, wind action and rainfall. In cities, buildings and trees can also interfere with successful dissemination, thereby lowering the casualty rate. Over the years, experts have tried to say how easy it would be to put chemical agents into the air handling system of a high-rise apartment building; however, this is simply not the case. Attacking ventilation systems of modern buildings is not simple.

Aum Shinrikyo was able to acquire the knowledge, chemicals, and equipment needed to synthesise sarin. It was an expensive research and development project – cost estimates range as high as $30 million. The cult had an 80-man program, housed in a state-of-the art facility, which was led by a PhD-level scientist, and it took at least a year between the time of conception and the initial production of sarin. Despite all this, the subway attack and the cult's earlier sarin attack in Matsumoto, Japan, they succeeded in killing only a dozen people.[54]

Conclusion. Chemical weapons are a poor choice for terrorists simply because they are extremely dangerous and difficult to use. Aum Shinrikyo, the Japanese doomsday cult, spent an estimated $30 million on chemical weapons research and managed to kill only 12 people with sarin nerve gas.[55] According to US government officials, about a dozen countries are believed to have chemical weapons programmes, but terrorists who lack assistance from national programmes (i.e., state sponsors) face daunting technical and operational challenges in weaponising and delivering the chemical weapon, especially on a large scale.[56]

Radiological Weapons

> Radiological weapons are not nuclear weapons – Hiroshima type weapons. If used, their impact will likely be limited. They are intended to cause terror or fear and disruption.
>
> – Jim Walsh, December 2001[57]

Radiological weapons have been around since the dawn of the nuclear age. Most countries that considered nuclear weapons also considered radiological weapons but concluded that they were not effective as military weapons, therefore leading state sponsors of terrorism not to pursue radiological terrorism.

That said, a radiological weapon is spread by utilising radiological dispersal devices (RDDs), or 'dirty bombs designed to distribute radioactive material through passive or aerosol or explosive means'.[58] Another option would be for a terrorist to use the radioactive material to contaminate food and/or water; however, this option is less favourable given the huge quantities of radioactive material that would be needed.[59]

The fact that most radioactive material is not soluble in water means that its use by a terrorist would be unlikely and impractical if the purpose is to contaminate reservoirs or other water supplies. Combined with the fact that any radioactive material presents safety risks to the terrorists themselves, indicates the enormous difficulties for a terrorist attempting to store, handle and disseminate radioactive material effectively.[60]

Despite this, radiological agents were involved in three 'incidents' in 2002. In May, Jose Padilla was arrested while planning to build and explode a radiological dispersal device in the United States. Reportedly, Padilla obtained the design for hydrogen fission weapons from the Internet and took them to Al Qaeda officials; they told him to think smaller, and instead create a 'dirty bomb'.[61] In July, British authorities uncovered a plot by the Real IRA attempting to steal plutonium from the Sellafield nuclear power station in the United Kingdom. Authorities believed they were attempting to make a 'dirty bomb'.[62] Later in the month, the *Guardian* newspaper reported that Chechen rebels stole an unspecified quantity of radioactive materials from the Volgodonskaya nuclear power plant near Rostov-on the-Don. The atomic power station denied the claims.[63]

Whether or not any of the examples above would have actually produced a 'dirty bomb' remains to be seen. Authorities were able to thwart the terrorists before they could achieve their desired results. While none of these examples would have killed thousands, they would have killed a few.

Radiological weapons kill or injure by exposing people to radioactive materials, like cesium-137, iridium-192 or cobalt-60. Those exposed to it are irradiated when they get close to or touch the material, inhale or ingest it.

Radiation damages cells in living tissue through ionisation, destroying or altering some of the cell constituents necessary for normal cell functions. The effects of a given device depend on whether the exposure is acute (i.e., brief or one time) or chronic (i.e., extended).

There are three types of radiological weapons: gamma emitters (i.e., cobalt and cesium), beta emitters (i.e., strontium and phosphorus) and alpha emitters (i.e., americium and radium). Gamma rays are uncharged radiation, similar to x-rays, which are high-energy particles that can easily pass through matter. Due to the high penetrability, gamma radiation can result in exposure to the entire body.[64]

Beta particles, found predominantly in fallout radiation, are extremely light, charged particles that can travel a short distance in tissue. The main threat from beta particles comes from them being internalised through inhalation or ingestion.

Alpha particles are large, charged particles that cannot travel and can be stopped by dead layers of the skin or by clothing. Alpha particles are of little external hazard but can cause significant regional cellular damage when internalised. The main threat from an RDD using an alpha emitter is from contaminated dust and other particles that might be inhaled or ingested.

Contrary to popular belief, RDDs are not really weapons of mass destruction. Few, if any people would immediately die after exposure to the ionising radiation from an RDD. 'While radiological attacks would result in some deaths, they would not result in the hundreds of thousands of fatalities that could be caused by a crude nuclear weapon.'[65] However, the use of a 'dirty bomb' would undoubtedly cause panic and produce severe economic damage, due to the extensive cleanup difficulties.

The real threat of a 'dirty bomb' is one of fear and disruption. The immediate victims would not be those from the initial blast, but instead those who panic over potential radiation exposure causing additional sufferers and disrupt rescue and evacuation efforts. Areas would remain off-limits for several months of expensive clean up, possibly including building demolition and soil replacement, which would cause further disruption.[66]

Availability of Information. Radiological materials that can be used in an RDD exist in a variety of forms in virtually every country of the world, and are generally loosely monitored and secured. The use of radioactive sources is widespread. They have many uses in industrial, agricultural, research and medical applications. In the medical field alone, approximately one hundred radioisotopes are used in various nuclear medical research, diagnosis, sterilisation and teletheraphy applications. Despite the wide use of radioactive sources, only a small portion of them poses a real threat as potential ingredients in a radioactive weapon.[67]

Manufacturing and Production. The materials necessary for the production of a 'dirty bomb' are relatively easy to get, and a science degree is not needed to know how to detonate the bomb. There are more than 18,000 sources of industrial radiation in America alone that could be pursued to develop radiological weapons, including nuclear waste stored at a power plant or radiological medical isotopes found in hospitals or research laboratories.[68]

The problem with building a 'dirty bomb' is that once you have all the necessary parts, putting the bomb together could potentially kill you. To make an effective bomb, you need immense amounts of radioactive material – which means either making a shield so heavy the bomb becomes impossible to move, or building a bomb without a shield – instant death for the bomb-maker from radiation poisoning.[69]

Some radioactive materials pose limited threats because of the relatively low activity levels. Low-level nuclear waste (waste generated by hospitals and industries) can be found at many different places; however, the radioactivity is not concentrated enough to pose much of a health risk.[70]

The only real concern for a radiological weapon comes from a terrorist acquiring plutonium; however, because the material could also be used in nuclear weapons, it is under tight security control and guard. Terrorists are unlikely to use high-level nuclear waste, like spent fuel, because the material is difficult to obtain, hard to work with and hard to hide. Security for spent fuel is significant and has been for years, and the safeguards that are used to deal with the hazardous nature of the waste makes theft a challenge.[71]

Delivery of Radiological Weapons. Radioactive material in very small particles or vapour disperses more outdoors, diluting any effect it may have had. Large radioactive particles do not travel far from the point of dispersion. It has often been asserted that 'dirty bombs' are relatively simple to develop – ignoring the technical challenge of devising a weapon that will produce the best possible particle size resulting in an effective weapon.[72]

Although unlikely, radiological weapons could be fabricated for delivery by ballistic or cruise missiles or an aircraft-delivered bomb. A weapon containing plutonium could also be released in aerosol form. Although spent fuel rods are sometimes discussed as potential sources of radiological material, they are hot, heavy and difficult to handle, making them a bad choice for terrorists.[73]

A radiological weapon is incapable of causing tens of thousands of deaths; however, it could kill or injure anyone who came into contact with it. Studies done for the Pentagon several years ago illustrate the range of threats – under one scenario, a backpack-sized 100-pound bomb with weakly radioactive particles, such as those used in cancer treatment, detonated near the Washington Monument would kill no one with radiation. However, a truck mounted device with the same amount of explosive, but with more than 100 pounds of bundled spent nuclear fuel rods, would produce potentially lethal doses of radiation for up to about a half a mile.[74]

In sum, in order for a radioactive weapon to disperse large amounts of radiation, it must contain highly radioactive material to begin with. This makes the weapon very dangerous to work with, and relatively easy to detect.

Conclusion. Terrorists are attracted to 'dirty bombs' because the material is easy to acquire, and while the effects of an attack are not great to human life, economically, it could be disastrous. 'The amount of radioactive material it would take to kill people in a matter of days or weeks is so high as to be insurmountable.'[75] In addition, massive amounts of radioactive materials would have to be packed into a bomb to register any immediate health effects, requiring a bomb that would be difficult to assemble, difficult to smuggle and dangerous to handle.[76]

Nuclear

> In hundreds of buildings around the world, hundreds of tons of nuclear material are dangerously insecure – vulnerable to being stolen and sold to terrorists or hostile states.
>
> – Matthew Bunn and Anthony Wier, 2002[77]

In the mid-1970s, the Congressional Office of Technology Assessment (OTA) concluded that a 'small group of people, none of whom have ever had access to the classified literature, could possibly design and build a crude nuclear device.'[78]

There is substantial and credible evidence that both terrorist groups and rogue states are actively trying to acquire stolen fissile material for nuclear weapons, or seeking to obtain stolen nuclear weapons. Only a few countries (and to date, no terrorist organisations) have the capability and desire to produce their own nuclear materials for nuclear weapons – but if stolen nuclear material were available on the black market, most states, and some well-organised terrorist groups could make a nuclear bomb. Both Al Qaeda and Aum Shinrikyo have attempted to buy stolen nuclear material, and Iran, Iraq, Libya and North Korea have all been seeking to acquire materials as well.[79]

A nuclear bomb and/or attacking a nuclear power plant is the only certain way for terrorists to achieve mass casualties and mass destruction. A nuclear explosion causes damage in four major ways. It creates blast waves that extend for approximately a mile or further and can destroy buildings and send debris flying at high speeds. It also creates a large heat source that can inflict lethal burns out to one-plus miles depending on atmospheric conditions, and can start large-scale fires. Immediate and lasting radioactivity is created. If the explosion occurs on the ground, as would most likely take place in a terrorist attack, the lasting radioactivity will be attached to ground particles that can be carried downwind and then 'fall out' tens of thousands of miles away from the explosion. Finally, the explosion will create an electromagnetic signal that interferes with communications and radars. [80]

A one-kiloton nuclear explosion will destroy most houses and kill almost everyone within a radius up to a third of a mile. A ten-kiloton explosion will give off the same blast effect about twice as far, but the burns and radiation in clear weather will kill people in a much farther radius. The heat, which causes the fires, might result in ranges much further out.[81] In 1981, the Nuclear Regulatory Commission estimated that an attack on the San Onofre power plant by a 'mobile bomb' like an airplane would lead to the deaths of over 130,000 people.[82]

The collapse of the Soviet Union invokes fears about security of Russian military facilities. So far, it appears that Russian strategic and tactical weapons were more secure than experts had initially estimated.[83] The areas that could cause concern are during their transportation for maintenance and/or dismantling, especially since Russian weapons are not subject to the same strict security measure as US nuclear weapons. However, if a terrorist did manage to steal or acquire a nuclear weapon through a black market purchase, there are still a number of sizeable barriers they would face in using and/or detonating it.[84]

There are three main ways for a terrorist to 'obtain' a nuclear weapon: (1) steal it, (2) buy it on the black market from a country in the former Soviet Union or Warsaw Pact, or (3) build it themselves. Building a nuclear weapon, capable of mass destruction, is an enormous challenge for states with well-funded and sophisticated programmes, let alone terrorist groups. That said, there are two types of nuclear devices that are easier to create than others: the implosion device, and the 'gun' type.[85]

Experts disagree over the level of knowledge and other materials required to develop a nuclear weapon. Richard Falkenrath, in his book *America's Achilles' Heel*, stated, 'most states and some exceptionally capable non-state actors could build a highly destructive 10-kilotonne weapon in several months at a cost of a few hundred thousand dollars – assuming they had access to sufficient quantities of fissile material'.[86] Other experts are far more sceptical. A number of states, despite aid from other nuclear powers, and espionage activities designed to support their R&D programs, still struggle to build nuclear weapons – suggesting that technical challenges remain high.

The ability of a terrorist group to weaponise fissile material into a nuclear weapon is difficult to assess. Without state support, a well-funded, technically competent terrorist group could assemble the necessary skills and facilities to weaponise fissile material. However, terrorist groups that are safely established within a safe-haven country would have a much easier time in researching and developing nuclear weapons, whether or not the country provided direct assistance to the nuclear effort. Without the opportunity to work uninterrupted for an extended period of time, a terrorist group might find the task daunting. However, were they to acquire fissile material, the group would then be in the position to rapidly build a nuclear weapon.[87]

In an interview for *National Geographic News*, journalist Peter Bergen stated, 'One of the best outcomes of the war in Afghanistan was severely interrupting this nuclear program that al-Qaeda [sic] had. Left alone for five years, who knows what they might have done.'[88] When the Taliban fell, US officials and journalists, like Bergen, were allowed access to former Al Qaeda safe houses. The documents found there left no doubt that Osama bin Laden was actively seeking information about nuclear weapons. During the last few years, bin Ladin had apparently met with Sultan Bashiruddin Mahmood, a Pakistani nuclear expert, who had a key role in the development of Pakistan's nuclear bomb.[89]

In November 1995, Chechen rebel leader Shamil Basayev claimed that his forces had access to nuclear weapons and materials. In an attempt to prove the claim, Basayev guided a Moscow television crew to Izmilovsky Park in Moscow, where a container of radioactive cesium was discovered.[90] In 2001, there were four documented nuclear incidents, two legitimate and two hoaxes. The first involved the seizure of five grams of highly enriched uranium in Paris. The second was a report from the Russian Defence Ministry, that terrorist groups had twice been caught 'casing Russian weapons-storage facilities'.[91] The two hoaxes consisted of stories that terrorists conspired to detonate a 10-kiloton nuclear bomb in New York and a threat from a psychologically unstable prison inmate to blow up the White House with a nuclear bomb.[92]

There are five simple facts that make nuclear weapons a deadly danger. First, terrorists have made it known they are interested in acquiring nuclear bombs, as in bin Laden's public statements and documents outlining Al Qaeda's nuclear programme recovered in Afghanistan.[93] Second, if terrorists could get a hold of highly enriched uranium (HEU) or plutonium, making the bomb could well be within the capability of a large and sophisticated group such as Al Qaeda. Making a gun-type bomb requires little more than 'slamming two pieces of HEU together fast enough'.[94] Producing an implosion bomb is more difficult for a terrorist to manage, but cannot be ruled out. Third, hundreds of tons of nuclear material in dozens of countries around the world are vulnerable to theft. Many of the 130 civilian research reactors using HEU fuel have no more security at night than a night watchman and a chain-link fence; making them unable to defend against attacks from large terrorist groups. There have already been documented cases of theft of real plutonium or HEU. This is not a hypothetical worry, but instead reality.[95] Fourth, if a terrorist could steal, buy or make a nuclear bomb, the United States could not stop them from smuggling it into the country. Thousands of tons of illegal drugs and illegal immigrants come into the United States every year, despite the massive effort to stop them. The necessary ingredients for a nuclear bomb can easily fit into a suitcase, and can be hard to detect.[96] Fifth, a crude bomb produced by a terrorist would be potentially capable of destroying the heart of a city, turning it into a modern Hiroshima. A bomb with the explosive power of 10,000 tons of TNT set off in Manhattan could kill half a million people, and cause of $1 trillion in direct economic damage.[97]

For years experts have been attempting to warn of the extraordinary risk that nuclear terrorism holds for humanity. September 11 was a wake-up call for everyone. The world lost the reassuring factor of low probability.[98] Terrorists have made it clear they want nuclear weapons and are going to try to get them. Whether they build it, acquire it, steal it, or crash a plane into a nuclear power plant, the threat remains the same.[99] Of the four types of unconventional weapons, nuclear terrorism is the most credible threat the US faces.

Availability of Information. Obtaining information on building a nuclear bomb is as easy as visiting the local library, and reading a book called *Los Alamos Primer: First Lectures On How to Build An Atomic Bomb*. While the book is not an exact recipe for production, it is considered a ‘good guide to the physics of nuclear fission’.[100] Saddam Hussein’s bomb development team allegedly had a copy of it in their library.

A handful of skilled personnel could successfully design a simple nuclear weapon using publicly available information. Nuclear weapons designs, contrary to popular belief, are not available on the Internet. What people find are rough sketches illustrating basic design concepts. However, more information is required to build a nuclear bomb than what is provided. Designers would still have to determine the main characteristics of the fissile material needed for use in the weapon, which governs how much material is needed to produce a nuclear explosion. Designers also have to know performance characteristics of the explosives, propellants and firing circuitry used to assemble the fissile material. Designers can now get raw data on the behaviour of nuclear weapons material – its readily available in published materials.[101]

There are also a number of readily available books, pamphlets and other printed materials that profess to provide information relating to the manufacture, design and fabrication of nuclear devices. Some books include, *The Curve of Binding Energy* (J. McPhee, 1974), *U.S. Nuclear Weapons: The Secret History* (C. Hansen, 1966), and *The Swords of Armageddon* (C. Hansen, 1986).[102]

After the collapse of the Soviet Union, nuclear weapons once formerly under tight control were allowed to 'go walking'.[103] Instead of keeping the nuclear programme under one government, the Soviet breakup forced nuclear weaponry to fall under the control of various smaller governments. The disintegration of the Soviet economy put many nuclear scientists, engineers and military weaponeers out of jobs, and without a way to feed their families.[104] The 'black market' was developed as a way to sell military weapons and for former government personnel to make a profit – Russia has one of world's largest 'black markets' for the weapons and supplies that terrorists want. In the past three years, Russian authorities have broken up 601 nuclear-smuggling rings.[105]

Manufacturing and Production. A terrorist seeking to use nuclear weapons as their method could do so in two different approaches: a bomb, or attacking a nuclear power plant. Terrorists bent on assembling a nuclear weapon must acquire sufficient quantities of plutonium or HEU that are in a weapons-usable form. Depending on the quantity and form of material that it initially acquires, the terrorist group may need to convert fissile materials from one form to another, requiring expertise in chemistry and access to necessary chemicals and equipment.[106]

Much of the world's less protected stocks of fissile material cannot be used directly in nuclear weapons. According to an estimate done several years ago over 700 tons of plutonium is contained in highly radioactive spent nuclear reactor fuel that has been discharged from commercial nuclear power reactors. However, before this plutonium could be used in nuclear weapons, it would have to be separated from the leftover uranium, cladding and fission products in a laboratory or reprocessing facility; making it unlikely that a terrorist group would be able to have access to such a facility or carry out this type of activity without being detected.[107] There are still other less protected materials that pose a greater risk of diversion, but would still require purification and chemical procession to make them usable for nuclear weapons (see Table 4).

The easiest method of attack is through a nuclear bomb. The type of nuclear explosive device that a terrorist group might assemble depends on the type and quantity of fissile material that they can obtain. Each type of device has advantages and disadvantages. A gun-assembly device can only be produced using HEU, which poses less of a radiological threat to the terrorist building the weapon, and global stocks of HEU are larger than stocks of plutonium, and may be less protected.[108]

The implosion nuclear weapon can be produced with either HEU or plutonium, and requires less of either type of material than a gun-assembly device. However, implosion devices are more complex than gun assembly devices and are widely believed to be more difficult to produce. Therefore,

TABLE 4
FORMS OF FISSILE MATERIAL AND ASSOCIATED ACTIVITY TO CONVERT MATERIALS TO A WEAPONS-USABLE FORM

		Nuclear weapon activity	
Form (separated from spent fuel)	Weapon design	Conversion to metal*	Foundry and machining
Pure metal	Yes	No	Yes
Oxide	Yes	Yes	Yes
Scrap or residue	Yes	Yes	Yes
Intermediate forms	Yes	Yes	Yes

*Includes dissolutions, purifications, precipitations, calcinations and metal reduction
Source: Kevin O'Neill, Institute for Science and International Security 'The Nuclear Terrorist Threat', August 1997, pp. 1–2.

the predictability and reliability of an implosion device is less certain than a gun assembly device.[109]

In addition to the necessary fissile materials, a nuclear explosive device requires several non-nuclear components. For an implosion system, terrorists would need to purchase and/or acquire lenses, high-speed switches, some form of a neutron generator, an iron or depleted uranium tamper, and possibly a natural uranium reflector. To assemble these parts requires knowledge and ability to operate specialised machine tools. Access to them and other necessary items has been restricted.

The US Office of Technology Assessment determined that it would take approximately $1 million dollars to fund a nuclear weapons project. The critical element is the hardware. About 2.5 to 8 kg of uranium (U-235) or plutonium (Pu-239) are needed to develop a one-kiloton nuclear weapon. For low-tech designs, 15 to 25 kg are required.[110]

Due to the vastness of its arsenal and stockpile of highly enriched uranium and plutonium, Russia remains the most probable source of a nuclear weapon or material from which one could be made. Despite all the improvements that have been made in the past ten years, many of these weapons remain vulnerable to theft by a serious organised effort.[111] In 1994, Prague police seized 2.7 kg of Russian HEU, and in 1996 Lithuanian police recovered 10 kg from a 100 kg uranium cache stolen from a nuclear reactor in 1992.[112] After Russia, Pakistan and North Korea are the most probable countries from which to 'obtain' nuclear weapons and/or materials.[113]

Enriched materials are not required for nuclear weapons; a bomb can be produced from reactor-derived as opposed to weapons-grade plutonium; the task however is much more challenging without it. Countries that have nuclear weapons prefer weapons-grade material like HEU due to its reliability and low quantity needed. A terrorist, however, would probably not care if his bomb was heavier, or if it 'fizzled, thus yielding a two-kilotonne blast instead of 20'.[114]

If a terrorist group did not have the capabilities to produce the bomb themselves, they could consider purchasing or acquiring a ready-made bomb on the 'black market'; to date there has been no evidence that any group has been able to do this, but there has been discussion about Russian nuclear 'suitcase bombs'. In 1996, Russian General Lebed raised the possibility that a number of small portable Russian nuclear bombs, named 'suitcase bombs', were missing. General Lebed later retracted the claim.[115]

The second method of nuclear terrorism is attacking a nuclear power plant, with the aim of causing a massive release of radioactive material. Most nuclear facilities have security measures to counter a terrorist attack, such as a well-trained guard and safety mechanisms to prevent the release of radioactivity. However, critics argue that security measures are ineffective in preventing highly trained, well-armed terrorists entry into critical areas of a nuclear facility, sabotage by insiders or the deliberate crashing of a hijacked airliner into a nuclear facility.[116] During a *Dateline* interview on nuclear power plant security, Paul Leventhal, founder of the Nuclear Control Institute stated the following:

> The security guards at half of the nuclear power plants in the United States have failed to repel mock terrorist attacks against safety systems designed to prevent a reactor meltdown. These are so-called 'force-on-force' exercises supervised by the Nuclear Regulatory Commission (NRC). The NRC refuses to take enforcement action in response to the failures, and is in the process of weakening the rules of the game in response to industry complaints. Sabotage of nuclear power plants may be the greatest domestic vulnerability in the United States today.[117]

Considering that a nuclear plant contains more than a thousand times the radiation than that released in an atomic bomb blast, the magnitude of a single attack could reach beyond 100,000 deaths and the immediate loss of tens of billions of dollars. The land and properties destroyed would remain useless for decades and would become a stark reminder of the terrorist's ideology.[118] At some of the nuclear plants, a large bomb detonated offsite could cause enough damage to lead to a deadly release of radiation or even a meltdown.[119]

Another consideration for nuclear plants is insider sabotage. Robert Pollard, a former engineer for NRC, wrote a report in 1975 on using publicly available information to plan an act of sabotage. Pollard used only common tools that could be found at the local hardware store in his report. In the report he stated: 'A janitor could be trained to do it. And there are things he could do to be sure it's irreversible.' The Union of Concerned Scientists has documented over 120 cases of sabotage at US nuclear plants. Most of them were perpetrated by disgruntled employees – they have cut electrical cables, dumped chemicals into fuel ponds and water systems, set fires, drilled holes in equipment, smashed security cameras, and many other crimes.[120]

Other incidents that have raised concerns include missing safeguarded documents, which include portions of security plans stored on computer disks. On numerous occasions the Millstone Plant in Connecticut has lost security documents, but has yet to change their security plan.[121]

Delivery of Nuclear Weapons. Despite their best and heightened efforts, US Customs officials acknowledge that there is no way they can check every ship, plane and cargo container that arrives in the United States every year. With more than 16 million containers to check, more than 12,000 miles of coastline and approximately 14,000 airports to control, the sheer magnitude of the task suggests that there is a definite chance a bomb could get through.[122]

Consider for a moment that the bomb dropped on Hiroshima used only 50 kg of HEU, (roughly the size of a basketball). The bomb dropped on Nagasaki contained 5 kg of Pu-239 (as big as a baseball).[123] Terrorists could ship parts of the bomb and then reassemble it at the target location; or they could use a fishing boat, freighter or yacht.[124]

Within the target country, a nuclear weapon could be shipped by commercial transport service (i.e., FedEx), whole or in pieces. Weapons delivered this way could either be fused to detonate on their own – at a particular time, or when the container is opened – or received by agents near the target for final assembly, delivery or detonation.[125]

Other means of delivery could include trucks, hot-air balloons and tankers. If a terrorist group wanted to detonate a nuclear bomb in a major city (i.e., Manhattan, Washington, DC), they have many options available to them. They could buy a car or get a commercial truck. In a city the size of Manhattan, 1.5 million vehicles enter the central business district daily, and over 7 million trucks a year cross the George Washington Memorial Bridge into Manhattan, an average of over 19,000 a day. Approximately 167,000 people ride the subway during a typical commute in Washington, DC In sum, the volumes of traffic are immense, and without a specific warning of an attack, it would be impossible to find and stop a single vehicle or a few people carrying a ‘suitcase bomb’.[126]

The methods of attack for a nuclear power plant are similar to those of a nuclear bomb. A terrorist could fly a plane into the plant, use suicide bombers inside automobiles to drive through the gates, and get as close to the building as possible before crashing, or infiltrate the power plant and sabotage it from the inside.

Conclusion. There is credible evidence that terrorist groups are actively looking to acquire stolen fissile material to produce nuclear weapons, or acquire ready-made stolen nuclear weapons. To date, only a few states and no terrorist groups have both the capability and desire to produce their own nuclear materials; however, if stolen nuclear materials were available on a nuclear black market, most states, and some well-organised terrorist groups, such as Al Qaeda, could potentially make a nuclear bomb.[127]

It is a fact that both Al Qaeda and Aum Shinrikyo attempted to buy stolen nuclear material. Bin Laden has called the acquisition of WMD a 'religious duty'. Not only has his group made repeated attempts to purchase stolen nuclear material, but they have tried to recruit scientists to help them with the weapon design and construction.[128]

The real threat, however, lies with terrorists attacking power plants. They are a low-tech, low-cost, high-result operation. After September 11, concerns about their vulnerability surfaced for the first time, and US troops were deployed to guard them. While nuclear reactors are the most robust engineering of all civilian buildings, they were not designed to withstand a direct hit by a passenger jet full of fuel. An attack similar to that would release tons of radioactive material.[129]

The US Nuclear Control Institute's recent report of the International Task force on the Prevention of Nuclear Terrorism recommended authorising guards to use deadly force, deploying anti-aircraft weapons against suicide planes, deploying jet fighters to patrol reactors, improving physical barriers and conducting background checks on all plant employees and contractors to prevent insider sabotage or theft of nuclear material.[130] The power industry, however, balked at the financial costs, and thus nothing was done.

CONCLUSIONS

All modern societies are vulnerable to the massive loss of life from an attack involving a weapon of mass destruction. The vulnerability has existed for many years; it is the combination of accessible weapons, materials, porous borders, free and open societies and high population densities in cities. The events of 11 September, 2001 have made government officials and the general public very aware of the damage and destruction terrorists are capable of committing.

The new breed of religiously motivated terrorists has repeatedly sought to achieve mass-casualties on the grand scale. An attack using biological, chemical, radiological or nuclear weapons would be the next logical step for them. A terrorist could fly a commercial plane into a nuclear power plant, purchase a 'suitcase bomb' on the black market and detonate it in Baltimore Harbor, or could send anthrax letters through the mail.

This article has discussed whether these scenarios were possible. Many experts say not right now, with the exception of nuclear weapons. Terrorists are likely to continue using conventional weapons such as guns and explosives. The other types of WMD, such as biological, chemical and radiological, are extremely difficult to manage, require enormous preparation, investment in personnel, and money.

During an interview on PBS, Defense Secretary Rumsfeld stated, 'global terrorists wouldn't hesitate a second to use weapons of mass destruction (WMD) if they had them and the evidence already exists that they have been trying to acquire such weapons'.[131]

While there has been evidence that terrorists are actively seeking WMD, there is no evidence they have acquired them, or have the capability to produce them. Material and 'recipes for production' are more accessible today than ever. They can be downloaded from the Internet, checked out from the library or even purchased over the counter in drugstores. However, producing WMD is another matter.

Biological weapons, always considered the biggest threat to the United States, are actually not a threat. Terrorists are interested in biological weapons due to the availability of biological agents, and maximum destruction that *could* be achieved. However, producing a biological weapon is extremely complicated (usually requiring someone with training in biology and laboratory skills), and dissemination is entirely dependent on environmental factors.[132]

Chemical weapons are extremely lethal man-made poisons that can be disseminated as gases, liquids or aerosols, which if disseminated correctly could kill several hundreds of people. But they are not easy to acquire or use, thereby making them a poor choice for terrorists. Currently, a dozen countries are believed to have chemical weapons programmes; however, terrorists lacking assistance from state sponsors face challenges in weaponising and delivering the chemical weapon, especially on a large scale.[133] If terrorists have their mind set on using chemical agents, they would probably rely on industrial chemicals or common poisons to accomplish their goal.[134] The production of the agents would be simple, and the low-tech effect would still achieve results, just not mass casualties.

Radiological weapons appeal to terrorists because they require little technical knowledge to build the RDD, and the material used is widely available in medicine, industry and agriculture.[135] However, developing an RDD is dangerous – handling the radioactive material is not only a safety risk to the terrorists themselves, but it also proves difficult for a terrorist attempting to store, handle and disseminate radioactive material effectively.[136] Another problem with radioactive material is that massive amounts of it would have to be loaded into a bomb to register any immediate health effects, requiring a bomb that would be hard to assemble, smuggle and handle.[137]

Nuclear terrorism, on the other hand, is a much more realistic threat. Terrorist groups such as Al Qaeda and Aum Shinrikyo are two groups known to have expressed interest in acquiring nuclear weapons. Groups with the time, money, materials and capabilities might have a chance of producing a nuclear bomb. Those groups that do not have the time or capabilities but have the money may consider buying a ready-made nuclear bomb on the black market. However, the simplest, and most effective method would be to attack a nuclear power plant. Many of the 160 in the United States are poorly guarded, lack efficient security measures and cannot withstand an attack by air or a high-power suicide truck bomber. Attacking a nuclear power plant would be low tech, low cost, high impact and mass casualty. Exactly what a terrorist is looking for.

In sum, while it is not probable that terrorists will use weapons of mass destruction in the near future, simply because conventional weapons are a proven technique, and are capable of achieving the same results as some of the WMD methods, terrorist groups are likely to continue in their pursuit for weapons of mass destruction. While biological and chemical agents achieve the end result terrorist seek (i.e., mass casualties), they are not good choices due to complexity of development and delivery. Radiological weapons are extremely dangerous in their development, and do not achieve the end result that terrorist groups seek. Nuclear weapons are by far the best choice for terrorists. Graham Allison, director of the Belfer Center for Science and International Affairs at Harvard's John F. Kennedy School of Government, stated the following:

> The United States must come to grips with the prospect of facing a terrorist strike using nuclear materials–a 'nuclear 9/11' – within the coming decade … I believe that Al-Qaeda and groups like it will try to construct or acquire a nuclear weapon. Given the right materials – a grapefruit- or soccer ball-sized amount of fissionable material is sufficient – several masters-level nuclear engineering students from Ohio State with several hundred thousand dollars and the type of equipment you could purchase off the shelf at Radio Shack could make a device that would explode. The last time I checked, researchers at Los Alamos, trying to develop strategies to combat this threat, had come up with sixty-nine different workable designs for a nuclear device.

The plain and simple truth is that the construction of a nuclear weapon is no longer beyond the means of groups with sufficient funds, expertise and materials at their disposal.[138]

NOTES

1. Laura Parker, 'Terrorist's Most Likely Weapon Here? Bombs'. *USA Today*, 15 May 2003, available at ⟨http://www.usatoday.com/news/nation/2003-05-15-bombs-cover_x.htm⟩, accessed 8 November 2003.
2. William J. Perry, 'Preparing for the Next Attack', *Foreign Affairs* 80 (November/December 2001), p.32.

3. Richard A. Falkenrath, Robert D. Newman and Bradley A. Thayer, *America's Achilles' Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack* (Cambridge, MA: Harvard University, 1998), pp.2–3.
4. Wayne Turnbull and Praveen Abhayaratne, '2002 WMD Terrorism Chronology: Incidents Involving Sub-National Actors and Chemical, Biological, Radiological and Nuclear Materials', Monterey Institute of International Studies, p.3, available at ⟨http://cns.miis.edu/pubs/reports/pdfs/cbrn2k2.pdf⟩, accessed 23 November 2003.
5. Richard K. Betts, 'The New Threat of Mass Destruction', *Foreign Affairs*, Vol.77, No.1 (January/February 1998), p.32.
6. Kathleen M. Vogel, 'Bioterrorism by Bin Laden: Is This the Next Real Threat?' *Ithaca Journal*, available at ⟨http://www.eindi.cornell.edu/9-11/content/pdf/bioterrorism-vogel.pdf⟩, accessed 9 November 2003.
7. Council on Foreign Relations, 'Terrorism Q&A: Responding to Chemical Attacks', available at ⟨http://www.terrorismanswers.com/security/chemical_print.html⟩, accessed 9 November 2003.
8. David Isenberg, 'Dirty Nukes: The Threat and the Response', available at ⟨http://www.basicint.org/pubs/Notes/DirtyNukes.htm⟩, accessed 9 November 2003.
9. Rose Gottemoeller, 'Nuclear and Radiological Terrorism' *Proliferation Brief*, Vol.5, No.14 (1 October 2002).
10. Bruce Hoffman, Viewpoint: Terrorism and WMD: Some Preliminary Hypothesis', *The Nonproliferation Review* (Spring–Summer 1997).
11. RAND, 'First Annual Report to The President and The Congress of the Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction', Chapter I. Assessing the Threat (Washington, DC: RAND, 1999), pp.9–11 (herein after referred to as Advisory Panel Report).
12. Peter R. Lavoy, Scott D. Sagan and James J. Wirtz, *Planning the Unthinkable: How New Powers Will Use Nuclear, Chemical and Biological Weapons* (Ithaca, NY: Cornell University Press, 2000), pp.204–205.
13. Ibid., p.205.
14. David M. Haugen, *Biological and Chemical Weapons* (San Diego, CA: Greenhaven Press, 2001), p.13.
15. Turnbull and Abhayaratne (note 4), p.5.
16. Falkenrath et al. (note 3), p.112.
17. Lisa D. Rotz, Ali S. Khan, Scott R. Lillibride, Stephen M. Ostroff and James M. Hughes, 'Public Health Assessment of Potential Biological Terrorism Agents', *Emerging Infectious Disease*, Vol.8, No.2 (February 2002).
18. Ibid.
19. Ibid.
20. Advisory Panel Report (note 11), p.22.
21. William Broad, 'Sowing Death: A Special Report; How Japan Germ Terror Alerted World', *New York Times*, 26 May 1998.
22. Advisory Panel Report (note 11), p.23.
23. Sun-Sentinel.Com, 'Chronology of Anthrax Attacks', available at ⟨http://www.sun-sentinel.com/news/local/southflorida/sfl-1013anthraxchronology.story?coll = sfla-home-headlines⟩, accessed 15 November 2003.
24. Jessica Stern, 'The Prospect of Domestic BioTerrorism', *Emerging Infectious Diseases*, Vol.5, No.4 (July–August 1999), p.522.
25. Ibid., p.24.
26. Ibid.
27. Falkenrath et al. (note 3), p.113.
28. Ibid., p.114.
29. Amy E. Smithson and Leslie-Anne Levy, *Axatia: The Chemical and Biological Terrorism Threat and US Response*, Report No.35 (Washington, DC: The Henry L. Stimson Center, 2000), p.49.
30. Ibid., p.51.
31. Ibid.

32. Karl Lowe, ‘Analyzing Technical Constraints: Are They Still Important?’, in *Terrorism with Chemical and Biological Weapons: Calibrating Risks and Responses* (Alexandria, VA: Chemical and Biological Arms Control Institute, 1997), pp.61–2.
33. Smithson and Levy (note 29), pp.54–5.
34. Vogel (note 6).
35. Jonathan B. Tucker and Amy Sands, ‘An Unlikely Threat’, *The Bulletin of Atomic Scientists*, Vol.55, No.4 (July/August 1999), pp.46–52.
36. Turnbull and Abhayaratne (note 4), p.7.
37. Ibid., p.5.
38. Advisory Panel Report (note 11), p.26.
39. Ibid.
40. Lavoy et al. (note 12), p.4.
41. Smithson and Levy (note 29), p.29.
42. Ibid.
43. Amy E. Smithson, *Separating Fact from Fiction: The Australia Group and the Chemical Weapons Convention*, Henry L. Stimson Center Occasional Paper 34, available at ⟨http://www.stimson.org/pubs.cfm?ID = 35⟩, accessed 2 November 2003.
44. Smithson and Levy (note 29), p.31.
45. Ibid., p.32.
46. Ibid., p.33.
47. Ibid.
48. Ibid.
49. Ibid., p.34.
50. RAND, ‘Natural Hazards Resource Working Paper #107 Major Terrorism’ *Gilmore Report I*, 15 December 1999, *a*vailable at ⟨http://www.rand.org/nsrd/terrpanel⟩ accessed 11 November 2003.
51. Smithson and Levy (note 29), p.35.
52. Robert K. Mullen, ‘Mass Destruction and Terrorism’, *Journal of International Affairs*, Vol.32, No.1 (Spring/Summer 1978), p.77.
53. Smithson and Levy (note 29), p.36.
54. Advisory Panel Report (note 11), p.28.
55. Council on Foreign Relations, ‘Terrorism Q&A: Responding to Chemical Attacks’ (note 7).
56. Elisa D. Harris, ‘Chemical and Biological Weapons: Prospects and Priorities After September 11’, *The Brookings Review*, Vol.20, No.3 (Summer 2002), p.24.
57. Jim Walsh, ‘America At War: Weapons of Mass Destruction’, *WashingtonPost.Com*, 5 December 2001, available at ⟨http://www.washingtonpost.com/wp-srv/liveonline/01/politics/walsh120501.htm⟩, accessed 7 December 2001.
58. Advisory Panel Report (note 11), p.33
59. Ibid.
60. Ibid.
61. Turnbull and Abhayaratne (note 4), p.14.
62. Ibid., p.16.
63. Ibid.
64. Center for the Study of Bioterrorism & Emerging Infections, ‘Radiological Terrorism Fact Sheet: Radiological Weapons – “Dirty” Bombs’, September 2002, available at ⟨http://www.slu.edu/colleges/sph/csbei/bioterrorism/other/dirty.pdf⟩, accessed 2 November 2003 (hereinafter cited as CSB&EI).
65. Canadian American Strategic Review, ‘An Assessment of the Threat of Nuclear Terrorism: “Dirty Bombs” or RDDs (Radiation Dispersal Devices), Part 3, October 2003, available at ⟨http://www.sfu.ca.casr/ft-frost3.htm⟩, accessed 9 November 2003.
66. CSB and EI (note 64).
67. Ibid.
68. Ibid.
69. ‘The Mechanics of a ‘Dirty Bomb’, CBS News, 23 April 2003, available at ⟨http://www.cbsnews.com/stories/2002/04/23/attack/main507031.shtml⟩, accessed 2 November 2003.

70. W. Robert Johnston, 'Dirty Bombs and Other Radiological Weapons', 21 September 2003, available at ⟨http://www.johnstonsarchive.net/nuclear/dirtybomb/html⟩, accessed 2 November 2003.
71. Ibid.
72. Ibid.
73. Advisory Panel Report (note 11), p.33.
74. Lee Bowman, 'The Real Dirt on Dirty Bombs', Scripps Howard News Service, 5 December 2001, available at ⟨http://www.azstarnet.com/attack/indepth/id-dirtybombs.html⟩, accessed 2 November 2003.
75. David Fisher, 'Radioactive Attack Still Seen As Threat', *Seattle Post-Intelligencer*, 28 February 2002, available at ⟨http://www.nci.org/02/03f/01-02.htm⟩, accessed 9 November 2003.
76. Ibid.
77. Matthew Bunn and Anthony Wier, 'Controlling Nuclear Warheads and Materials: The Global Threat and Urgent Steps to Address It', Center for Nonproliferation Studies, 16 December 2002, available at ⟨http://www.nti.org/e_research/cnwm/overview/issue.asp⟩, accessed 23 November 2003.
78. Kevin O'Neill, Institute for Science and International Security, 'The Nuclear Terrorist Threat', (August 1997), pp.1–2.
79. Matthew Bunn, 'The Demand for Black Market Fissile Material', 11 February 2003, available at ⟨http://www.nti.org/e_research/cnwm/overview/issue.asp⟩, accessed 23 November 2003.
80. Center for International Security and Cooperation, 'Nuclear Explosion Fact Sheet', available at ⟨http://ldml.stanford.edu/cisac/pdf/Nuc_explosion.pdf⟩, accessed 24 November 2003.
81. Ibid.
82. Mycle Schneider, 'The Threat of Nuclear Terrorism: From Analysis to Precautionary Measures', 10 December 2001, available at ⟨www.ceip.org/files/projects/npp/pdf/011210-Terrorisme.pdf.⟩, accessed 23 November 2003.
83. Karl-Heinz Kamp, 'Nuclear Terrorism is Not the Core Problem', *Survival*, Vol.40, No.4 (Winter 1998–1990), p.170.
84. Advisory Panel Report (note 11), p.29
85. Ibid., p.31.
86. Falkenrath et al. (note 3), pp.135–6.
87. David Albright, Kevin O'Neill and Corey Hinderstein, 'Nuclear Terrorism: The Unthinkable Nightmare, *ISIS Issue Brief*, 13September 2001, p.2.
88. Brian Handwerk, 'Nuclear Terrorism – How Great is the Threat?', *National Geographic News*, 11 October 2002, available at ⟨http://news.nationalgeographic.com/news/2002/10/1011_021011_nuclear.html⟩, accessed 26 November 2003.
89. Ibid.
90. Ibid., p.3.
91. Adam Dolnik and Jason Pate, '2001 WMD Terrorism Chronology', July 2002, p.4, available at ⟨http://cns.miis.edu/pubs/reports/cbrn2k1.htm⟩, accessed 27 November 2003.
92. Ibid.
93. Bunn and Wier, 'The Global Threat.'
94. Ibid.
95. Ibid., p.3
96. Ibid.
97. Ibid., p.4
98. Schneider.
99. Chris Bullock, 'Nuclear Terror: The Next Step?', ABC News, 24 February 2002, available at ⟨http://www.abc.net.au/rn/talks/bbing/stories/s489516.htm⟩, accessed 29 November 2003.
100. David Hughes, 'When Terrorists Go Nuclear: The Ingredients and Information Have Never Been More Available', available at ⟨http://www.jihadunspun.net/OperationUSA/articles/wtgn01.cfm⟩, accessed 16 November 2003.
101. Falkenrath et al. (note 3), p.129.

102. Antiterrorism and Effective Death Penalty Act of 1996, US Public Law 104–132, 105th Cong. 1st Sess., available at ⟨http://www.usdoj.gov/criminal/cybercrime/bombmakinginfo.html⟩, accessed 16 November 2003.
103. Joseph Douglass and Sam Cohen, 'Realities of Nuclear Terrorism', *WorldNetDaily*, 8 November 2001, available at ⟨http://www.worldnetdaily.com/news/article.asp?ARTICLE_ID = 25248⟩, accessed 29 November 2003.
104. Peter Montague, 'Our Nuclear Achilles' Heel', *Rachel's Environment and Health News*, No.749, 7 August 2002, available at ⟨www.rachel.org/bulletin/pdf/Rachels_Environment_Health_News_2231.pdf⟩, accessed 29 November 2003.
105. Council on Foreign Relations, 'Terrorism: Questions and Answers – Russia', available at ⟨http://www.terrorismanswers.com/coalition/russia2.html⟩, accessed 29 November 2003.
106. O'Neill (note 78), p.2.
107. Ibid.
108. Ibid., p.5.
109. Ibid.
110. Andy Ho, 'Nuclear Terrorism a Very Real Threat', *Straits Times*, 14 Novembe3r 2001, available at ⟨http://straitstimes.asia1.com.sg/columnist/0,1886,56-84118,00.html⟩, accessed 16 November 2003.
111. Allison Graham, 'Nuclear Terrorism Poses the Gravest Threat Today', *Wall Street Journal Europe*, 14 July 2003, p.A1, available at ⟨http://bcsia.ksg.Harvard.edu/publications.cfm?program = CORE&ctype = article&item_id = 603⟩, accessed 23 November 2003.
112. Ibid.
113. Ibid.
114. Ibid.
115. Bullock (note 99).
116. Nuclear Threat Initiative, 'WMD411: Nuclear Terrorism', available at ⟨⟨http://www.nti.org/f_wmd411/fla6_4/html⟩, accessed 16 November 2003.
117. 'NBC Nuclear Plant Security Program Transcript', Dateline NBC, 28 October 2001, available at ⟨http://www.tmia.com/sabter.html⟩, accessed 29 November 2003.
118. Ibid.
119. Ibid.
120. Ibid.
121. Ibid.
122. Ho (note 110).
123. Ibid.
124. Ibid.
125. Falkenrath et al. (note 3), p.142.
126. Ibid., p.139.
127. Bunn, 'The Demand' (note 79).
128. Ibid.
129. Ho (note 110).
130. Ibid.
131. *Public Broadcasting Service* (PBS), May 22, 2002, 'Rumsfeld Says Terrorists Seeks Weapons of Mass Destruction', [Cited at 30 May 2003], *PBS News Hour*. Available at ⟨http://www.usembassy.it/file2002_05/alia/a2052308.htm⟩.
132. Vogel (note 6).
133. Harris (note 56), p.24.
134. Richard A. Falkenrath, 'Emerging Security Threats Confronting Nuclear, Biological and Chemical Terrorism', *Survival*, Vol.40, No.3 (Autumn 1998), p.48.
135. Isenberg (note 8).
136. Advisory Panel Report (note 11), p.33.
137. Ibid.
138. Graham Allison, 'Not If, but When: Imagining a Nuclear 9/11', available at ⟨http://www.inthenationalinterest.com/Articles/Vol1Issue7/Vol1Issue7Allison.html⟩, accessed 7 December 2003.